Data Assimilation: Synthesis technique for information from a numerical simulation model and large-scale measurement system

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Dependent variables in the numerical simulation can be considered as stochastic variables due to the uncertainty in the initial and boundary conditions and the imperfection of the numerical model. A natural idea to compensate for such insufficient information only via simulations is to combine observations with numerical models. Hence, a reasonable way of blending a numerical model and observation is now becoming a central issue in the earth science community. Data Assimilation is a technique for a synthesis of information from a dynamic (numerical) model and observation data. It is an emerging area in earth sciences, particularly oceanography, stimulated by recent improvements in computational and modeling capabilities and the increase in the amount of available observations. In statistical sense, data assimilation supposes two models: system model and observation model. The system and observation model correspond to large-scale numerical model-based simulations and large-scale satellite- and/or ground-based measurement systems, respectively. Past studies for data assimilation employed a linear Gaussian state space model and applied Kalman filter which is a fundamental technique for a recursive estimation on the state of a system. The Kalman filter based methods, however, do not allow for the strong nonlinear and/or non-Gaussian disturbance behaviors. The nonlinear non-Gaussian data assimilation method needs to be developed in an attempt to realize a quantitative prediction of the real world problems. In addition, it is impossible to make use of the multiple simulation models within the conventional data assimilation platform. In order to cope with this request, we develop a new data assimilation method, which we call Monte Carlo mixture Kalman filter.